

AMENDMENTS TO THE CLAIMS

1. (Currently Amended) A method of providing an electronic representation of data distribution of data elements ~~in a multi-dimensional data space derived from an~~ a plurality of images for at least one object or image by processing signals corresponding to the ~~object or image~~ plurality of images, the representation having a hierarchical structure, the method comprising:

(a) deriving an approximate representation of input data, derived from a plurality of images, the input data comprising the data distribution, the approximate representation comprising a plurality of data elements and forming a node in the hierarchical representation;

(b) deriving error data comprising errors of the data elements of the approximate representation;

(c) analysing the error data, to determine if the errors of the data elements meet predetermined criteria, and

(d) if the step of analysing determines that the errors of the data elements meet the predetermined criteria, marking the node as a leaf node in the hierarchical representation, or

(e) if the step of analysing determines that the errors of the data elements do not meet the predetermined criteria, repeating steps (a) to (d) recursively, using the error data as the data distribution, to form one or more further nodes in the hierarchical representation, and

(f) storing the final electronic representation of the data distribution of data elements comprising the nodes in a hierarchical representation on an electronic storage medium for use in image analysis.

2. (Currently Amended) A method as claimed in claim 1, wherein the ~~appropriate~~ approximate representation comprises data elements in a subspace of ~~a data space of~~ a data space of the data distribution of the input data.

3. (Previously Presented) A method as claimed in claim 2, wherein the subspace is derived using principal component analysis.

4. (Currently Amended) A method as claimed in claim 1, wherein step (e) further comprises:

(i) prior to repeating steps (a) to (d), clustering the errors of the data elements of the approximate ~~operation~~ representation to obtain a plurality of clusters;

(ii) marking each cluster as a child node, and

(iii) repeating steps (a) to (d) recursively for each cluster, using the error data for the given cluster as the data distribution, to form one or more further nodes in the hierarchical representation.

5. (Previously Presented) A method as claimed in claim 4, wherein the step of clustering involves fuzzy clustering using a membership function representing the degree of membership to a cluster.

6. (Previously Presented) A method as claimed in claim 4, wherein the step (e) (iii) further comprises:

(iv) for each cluster, deriving an approximate representation comprising a subspace representative of the cluster, using principal component analysis, each approximate representation forming a further node in the hierarchical representation.

7. (Currently Amended) A method as claimed in claim 6, wherein step (e) (iii) further comprises:

(v) for data elements in an approximate representation of a given cluster, deriving errors of the elements in the cluster subspace, and

(vi) ~~analyzing~~ analysing data elements of the errors.

8. (Previously Presented) A method as claimed in claim 7, wherein step (e) (iii) comprises:

repeating steps (v) to (vi) to produce further nodes in a hierarchical tree structure.

9. (Currently Amended) A method as claimed in claim 7, wherein step (e) (v) further comprises:

(vii) stopping the method if the step of ~~analyzing~~ analysing determines that the data elements meet predetermined criteria.

10. (Currently Amended) A method as claimed in claim 8, further comprising:
adding new nodes to the hierarchical tree structure by processing new input data.

11. (Currently Amended) A method of representing ~~an image a data element derived from~~ of an object or image by processing signals corresponding to the ~~object or image~~, the method comprising:

~~expressing the data element in terms of a representation derived according to claim 1.~~
providing a data model of the object or image as an electronic representation of a data distribution of data elements derived from a plurality of images for the object or image by processing signals corresponding to the plurality of images, the representation having a hierarchical structure, the data model constructed by the steps of:

(a) deriving an approximate representation of input data, derived from a plurality of images, the input data comprising the data distribution, the approximate representation comprising a plurality of data elements and forming a node in the hierarchical representation;

(b) deriving error data comprising errors of the data elements of the approximate representation;

(c) analysing the error data, to determine if the errors of the data elements meet predetermined criteria, and

(d) if the step of analysing determines that the errors of the data elements meet the predetermined criteria, marking the node as a leaf in the hierarchical representation, or

(e) if the step of analysing determines that the errors of the data elements do not meet the predetermined criteria, repeating steps (a) to (d) recursively, using the error data as the data distribution, to form one or more further nodes in the hierarchical representation, and

(f) providing the final data model as the electronic representation of the data distribution of data elements comprising the nodes in a hierarchical representation on a computer readable storage medium;

the method further comprising:

deriving a feature vector of the image, and

processing the feature vector of the image to derive a representation of the image in terms of the data model.

12. (Currently Amended) A method in claim 11 comprising expressing the feature vector element in terms of a tree structure having nodes and determining feature vector coefficients of the element for nodes of the tree structure.

13. (Currently Amended) A method as claimed in claim 12 comprising using a membership value representing the degree to which the feature vector ~~the data element~~ corresponds to a node.

14. (Previously Presented) A method as claimed in claim 13 comprising quantizing the coefficients and/or the membership values.

15. (Previously Presented) A method as claimed in claim 1 involving data derived from an image or images in a sequence of images.

16. (Previously Presented) A method as claimed in claim 1 wherein the object or image corresponds to a person or a face.

17. (Canceled)

18. (Canceled)

19. (Currently Amended) A method of matching or classifying a query feature vector ~~data element~~ derived from an image of an object or image by processing signals corresponding to the object or image, the method comprising comparing a descriptor of the query ~~data element~~ according to claim 17 with database descriptor elements according to claim 17 using a matching function. feature vector derived using the method of claim 11 with descriptors derived from feature vectors of a plurality of images in a database using the method of claim 11, the step of comparing using a matching function, and outputting an image matching or classification result.

20. (Currently Amended) An Apparatus set up to execute a method according to claim 1, for providing an electronic representation of data distribution of data elements derived from a plurality of images for at least one object or image by processing signals corresponding to the plurality of images, the representation having a hierarchical structure, comprising:

a processor configured to perform the steps of:

(a) deriving an approximate representation of input data, derived from a plurality of images, the input data comprising the data distribution, the approximate representation comprising a plurality of data elements and forming a node in the hierarchical representation;

(b) deriving error data comprising errors of the data elements of the approximate representation;

(c) analysing the error data, to determine if the errors of the data elements meet predetermined criteria, and

(d) if the step of analysing determines that the errors of the data elements meet the predetermined criteria, marking the node as a leaf node in the hierarchical representation,

or

(e) if the step of analysing determines that the errors of the data elements do not meet the predetermined criteria, repeating steps (a) to (d) recursively, using the error data as the data distribution, to form one or more further nodes in the hierarchical representation, and

a memory for storing the final electronic representation of the data distribution of data elements comprising the nodes in a hierarchical representation for use in image analysis.

21 (Currently Amended) The Apparatus as claimed in claim 20 further comprising a processor, memory and an image or object input means.

22. (Currently Amended) ~~Computer program embodied on a computer-readable medium for executing a method according to any one of claims 1 to 16 or 19.~~ A computer-readable medium having stored thereon computer executable program for providing an electronic representation of data distribution of data elements derived from a plurality of images for at least one object or image by processing signals corresponding to the plurality of images, the representation having a hierarchical structure, the computer program when executed causes a computer system to execute steps of:

(a) deriving an approximate representation of input data, derived from a plurality of images, the input data comprising the data distribution, the approximate representation comprising a plurality of data elements and forming a node in the hierarchical representation;

(b) deriving error data comprising errors of the data elements of the approximate representation;

(c) analysing the error data, to determine if the errors of the data elements meet predetermined criteria, and

(d) if the step of analysing determines that the errors of the data elements meet the predetermined criteria, marking the node as a leaf in the hierarchical representation, or

(e) if the step of analysing determines that the errors of the data elements do not meet the predetermined criteria, repeating steps (a) to (d) recursively, using the error data as the data distribution, to form one or more further nodes in the hierarchical representation, and

(f) storing the final electronic representation of the data distribution of data elements comprising the nodes in a hierarchical representation on an electronic storage medium for use in image analysis.

23. (Currently Amended) ~~Computer readable storage medium comprising a computer program as claimed in claim 21.~~The method of claim 1, wherein the input image data is derived from the plurality of images by deriving a feature vector for each image of the plurality of images.

24. (Currently Amended) ~~A method claim for providing a representation of data distribution of data elements in an N multi-dimensional data space where N is greater than 2, and as claimed in claim 1.~~The method of claim 23, wherein the data distribution comprises a plurality of feature vectors corresponding to the plurality of images.

25. (New) The method of claim 23, wherein:

step (b) comprises deriving error data comprising errors of representing the feature vectors using the approximate representation; and

step (c) comprises analysing the error data, to determine if the errors of the feature vectors meet predetermined criteria.

26. (New) A method of providing an adaptive electronic image data model representation derived from a plurality of images of at least one object or image by processing signals corresponding to the plurality of images, the image data model representation having a hierarchical structure, the method comprising:

(a) deriving an approximate representation of input image data derived from a plurality of images, the approximate representation comprising a plurality of data elements and forming a node in the hierarchical representation;

(b) deriving error data comprising errors of the data elements of the approximate representation;

(c) analysing the error data, to determine if the errors of the data elements meet predetermined criteria, and

(d) if the step of analysing determines that the errors of the data elements meet the predetermined criteria, marking the node as a leaf node in the hierarchical representation, or

(e) if the step of analysing determines that the errors of the data elements do not meet the predetermined criteria, repeating steps (a) to (d) recursively, using the error data as the data distribution, to form one or more further nodes in the hierarchical representation, and

(f) storing the final electronic image data model representation comprising the nodes in a hierarchical representation in an electronic storage medium for use in image analysis.

27. (New) A method of producing a generic electronic data model of the appearance of an object in an image using a plurality of images of the object, by processing signals corresponding to the plurality of images, the electronic data model having a hierarchical structure, the method comprising:

(a) deriving an approximate representation of input data derived from the plurality of images, the input data comprising a data distribution of feature vectors corresponding to the plurality of images, the approximate representation forming a node in the hierarchical representation;

(b) deriving error data comprising errors of representing the feature vectors using the approximate representation;

(c) analysing the error data, to determine if the errors of the feature vectors meet predetermined criteria, and

(d) if the step of analysing determines that the errors of the feature vectors meet the predetermined criteria, marking the node as a leaf node in the hierarchical data model, or

(e) if the step of analysing determines that the errors of the feature vectors do not meet the predetermined criteria, repeating steps (a) to (d) recursively, using the error data as the input data, to form one or more further nodes in the hierarchical data model, and

(f) storing the final hierarchical electronic data model comprising the nodes in an electronic storage medium for use in image analysis.

28. (New) A computer-readable medium having stored thereon computer executable program for representing an image of an object or image by processing signals corresponding to the image, the computer program when executed causes a computer system to execute steps of:

providing a data model of the object or image an electronic representation of data distribution of data elements derived from a plurality of images for at least one object or image by processing signals corresponding to the plurality of images, the representation having a hierarchical structure, the data model constructed by the steps of:

(a) deriving an approximate representation of input data, derived from a plurality of images, the input data comprising the data distribution, the approximate representation comprising a plurality of data elements and forming a node in the hierarchical representation;

(b) deriving error data comprising errors of the data elements of the approximate representation;

(c) analysing the error data, to determine if the errors of the data elements meet predetermined criteria, and

(d) if the step of analysing determines that the errors of the data elements meet the predetermined criteria, marking the node as a leaf in the hierarchical representation, or

(e) if the step of analysing determines that the errors of the data elements do not meet the predetermined criteria, repeating steps (a) to (d) recursively, using the error data as the data distribution, to form one or more further nodes in the hierarchical representation, and

(f) providing the final data model as the electronic representation of the data distribution of data elements comprising the nodes in a hierarchical representation on a computer readable storage medium;

deriving a feature vector of the image, and

processing the feature vector of the image to derive a representation of the image in terms of the data model.

29. (New) A computer-readable medium having stored thereon computer executable program for matching or classifying a query feature vector derived from an image of an object or image by processing signals corresponding to the object or image, the computer program when executed causes a computer system to execute steps of:

comparing a descriptor of the query feature vector derived using the method of claim 11 with descriptors derived from feature vectors of a plurality of images in a database using the method of claim 11, the step of comparing using a matching function, and

outputting an image matching or classification result.